Energy, Mines and Resources Canada

Énergie, Mines et Ressources Canada

CANMET

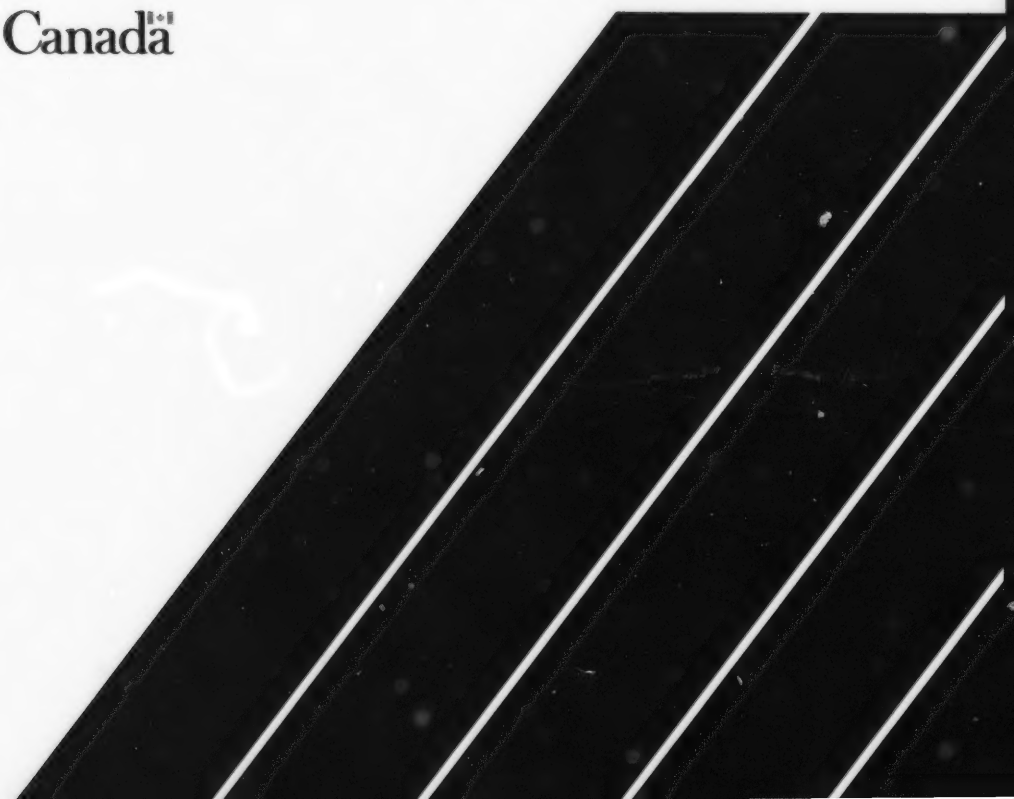
Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

Mineral Sciences Laboratories

Laboratoires des sciences minérales

Canada



NABST
COMMITTEE ON FEDERAL EXPENDITURES
IN SCIENCE AND TECHNOLOGY
(THE LORTIE COMMITTEE)

BOOK I

BACKGROUND INFORMATION

MINERAL SCIENCES LABORATORIES
DIVISION REPORT MSL 89-116 (IR)

54 pp

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BOOK I
BACKGROUND INFORMATION

1. INTRODUCTION

This document has been prepared in response to the needs and requirements of the NABST Committee on Federal Expenditures on Science and Technology. The committee, chaired by Mr. P. Lortie, has been called to assess the quality and effectiveness of the scientific research performed by government organizations. In making this assessment, the committee will review the research and investigations, technology development and transfer of technology, information and knowledge to the client group carried out by the organization. As one of two groups selected for review in the Department of Energy, Mines and Resources, the Mineral Sciences Laboratory (MSL) will be reviewed by the committee. The performance of MSL will be viewed in the context of the mandate of EMR, which includes the legislation relevant to the department's operations, together with those elements of policies, regulations and decisions that affect the operations of MSL.

The background information contained in Book I includes a description of EMR's mandate, and CANMET's mission statement. The organizational structure of the department is briefly reviewed and the policies and factors that affect CANMET's, and hence MSL's, plans and operations described. The strategic directions for MSL's work are reviewed, its areas of work are described and its budget history over the past 5 years is given. This review includes a list of all personnel and the curriculum vitae of the principal scientists, as requested.

2. THE MANDATE

2.1 EMR's Mandate

Energy, Mines and Resource's mandate is:

- To advance Canada's economic development through the mineral and energy sectors.
- To advance knowledge of Canada's landmass through scientific and science-related activities.

2.1.1 Important Aspects of EMR's Mandate for CANMET

In processing this dual mandate, several aspects have been identified as being particularly important to CANMET. These are:

- o environmental quality;
- o international competitiveness of client industries;
- o health and safety of workers in the mineral and energy industries;
- o security of supply of mineral and energy commodities;
- o economic equity and fairness;
- o Canada's sovereignty.

2.2 CANMET Mission Statement

Within the context of EMR's mandate, CANMETs' role can be best expressed by its mission statement:

In partnership with its clients, CANMET performs and sponsors predominantly commercial and cost-shared research and development and technology transfer with the following objectives:

- **o to enhance the competitiveness of the Canadian mineral and energy industries;**
- **o to improve health, safety and environmental control in the client industries; and**
- **o to support government policy initiatives.**

These 3 objectives have been categorized, for convenience, as:

- o Productivity;
- o Protection;
- o Policy.

In discharging its role, CANMET's programs are divided into four broad categories as shown in Figure 1.1, and described below:

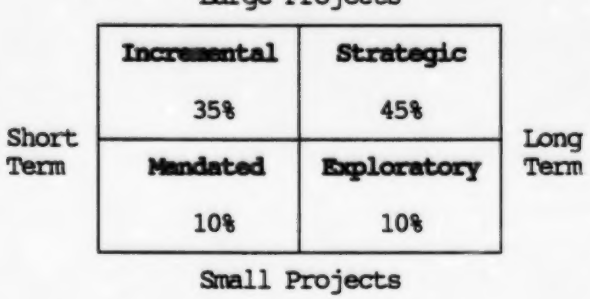


Figure 1.1 - Schematic relationship between CANMET's categories of Research and Development

- **Strategic Research and Development** covers research, development and pilot demonstration projects that establish and sustain CANMET's technology base. Projects in this group tend to be long term and major and, because of the associated risk, merit the leadership role being taken by CANMET in association with industry. This category accounts for about 45% of CANMET's budget.

- **Incremental Research and Development** consists of projects that extend and improve existing technologies and knowledge. The work responds to the more short term needs of industry, and is often done in conjunction with a single client under a cost-recovery or joint work agreement. Work in this category represents about 35% of CANMET's budget.

- **Mandated and Specialized Services** are routine procedures performed either because CANMET has unique facilities or expertise, or because CANMET has a legislated obligation. An example of the latter is explosives testing in support of the government's Chief Inspector of Explosives. The cost of work in this category, which represents about 10% of CANMET's budget, is normally fully recovered from the client.

- **Exploratory Research** includes basic research that is relevant to CANMET's mission but by its nature is neither supported nor sponsored by an outside client. This category accounts for about 10% of CANMET's budget.

3. ORGANIZATIONAL STRUCTURE

3.1 EMR - Sectors

EMR consists of nine sectors; three of these are concerned with the administration and management of the department, the others are concerned with energy, minerals and earth sciences, as shown in Figure 1.2. CANMET is a component of the Mineral and Energy Technology Sector. Figure 1.3 shows the CANMET organization chart.

3.2 CANMET - Branches

Organizationally, CANMET is divided into four branches, the Minerals Technology Branch, the Fossil Fuel Technology Branch, the Efficiency and Alternative Energy Technology Branch and the Policy, Planning and Services Branch. The Mineral Technology Branch consists of the Mining Research Laboratories (MRL), the Metals Technology Laboratories (MTL) and the Mineral

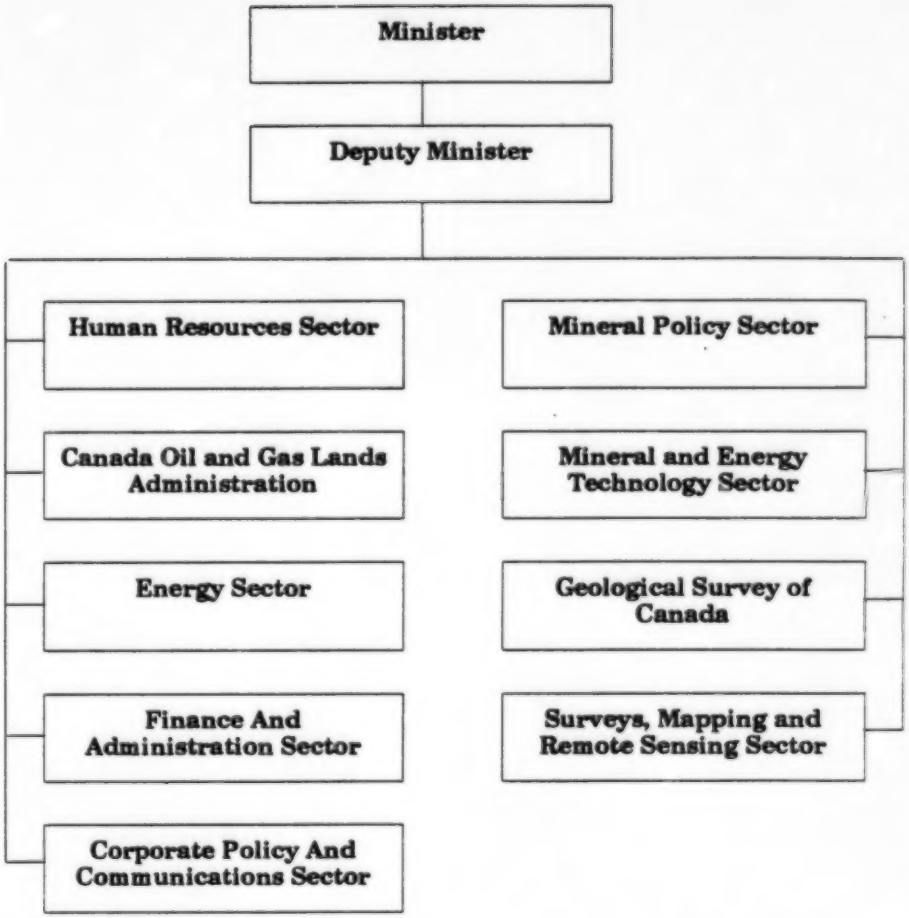


Figure 1.2

Energy Mines and Resources Organization Chart

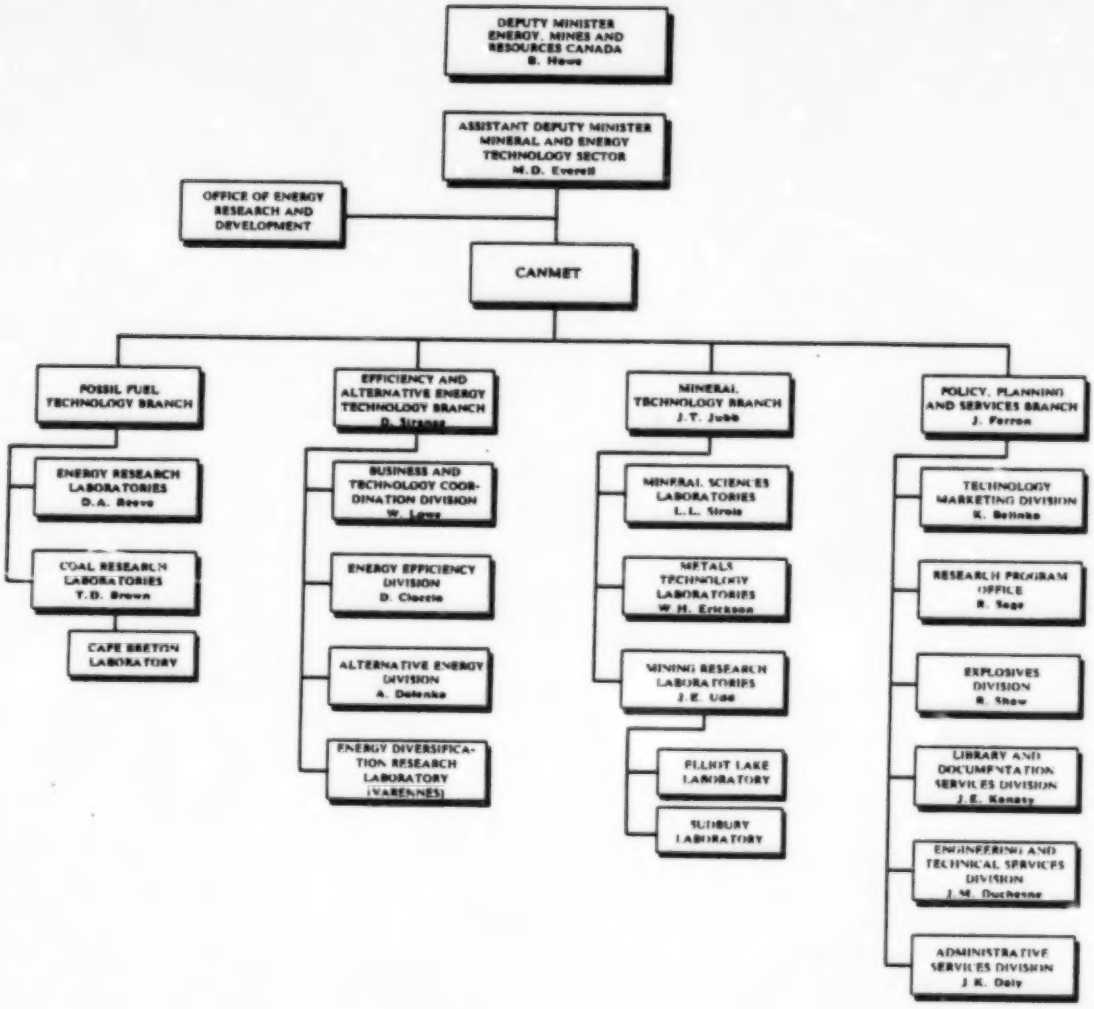


Figure 1.3

CANMET Organization Chart

Sciences Laboratories (MSL). The Fossil Fuel Technology Branch is made up of the Energy Research Laboratories (ERL) and the Coal Research Laboratories (CRL). The Efficiency and Alternative Energy Technology Branch has four divisions: Alternative Energy, Energy Efficiency, Business and Technology Coordination and the Energy Diversification Research Laboratories (at Varennes, Quebec). The responsibilities for EMR's technology development efforts in the areas of energy diversification and efficiency were taken over in mid-1989. The Policy, Planning and Services Branch provides administration, planning, financial and technical support to the operating laboratories.

3.3 Mineral Sciences Laboratories (MSL)

Director: Louis L. Sirois

Qualifications:

B.A. (Université de Montréal)

B.Eng. (Mining) (McGill University)

M.Eng. (Mineral Processing) (McGill University)

P.Eng. of Ontario

28 years at CANMET

Career:

1985-present	Director, Mineral Sciences Laboratories, CANMET
1961-1985	Various positions, from Research Scientist, to Section Head, Program Coordinator, Advisor to MSL Director and Director General of CANMET.
1959-1961	Lecturer, McGill University
1957-1959	Mine Planning, International Nickel Co.

The Mineral Sciences Laboratories activities are focussed on the development of improved technologies for processing, extracting and refining Canada's mineral resources. MSL and the Canadian mineral industry cooperate to develop technology to enhance Canada's competitive position in world markets. The primary considerations are:

- o to enhance competitiveness by improving processing efficiency and productivity;
- o to develop and evaluate new processes;
- o to decrease negative impacts on health, safety and the environment;
- o to find new applications for mineral use;
- o to support policy initiatives.

MSL's scientific and technical staff possess a wide range of skills, from mineral dressing to metal refining, which they apply to both large and small-scale R&D projects, with clients from all facets of the mineral industry. MSL's programs are reviewed annually by the Minister's National Advisory Council to CANMET, comprised primarily of industry experts. The council makes recommendations to the Minister concerning generic mineral programs considered vital to the national interest.

MSL is made up of three operational laboratories and an Office of Business Development, all located in the National Capital Region. The laboratories and their primary activities are described briefly below; a detailed review of each of the laboratories is given in Book II of this submission.

Mineral Processing Laboratory (MPL)

Manager: **Frank R. Campbell**

Qualifications:

Eng. Dipl. (St. Francis Xavier)

B.Eng. (Met) (Tech-Univ. of Nova Scotia)

Ph.D. (London, Royal School of Mines)

D.I.C. (Imperial College)

4 years at CANMET

Career:

1986-present	Manager, Mineral Processing Laboratory, CANMET
1982-1986	Science Advisor, Office of Energy R&D, Energy, Mines and Resources
1976-1982	R&D Program Manager, Atomic Energy Control Board
1971-1976	Research Scientist, Atomic Energy of Canada Limited

MPL has a professional, technical and administrative staff of about 60 people. The laboratory is equipped to perform:

- o mineralogical investigations to characterize ores, concentrates and minerals, and to design and develop processing circuits;
- o ore dressing studies, to provide milling and concentrating flow-sheet design and investigate new processes and processing equipment;
- o the study of industrial minerals;
- o the study of concretes;
- o the study of ceramics.

Extraction Metallurgy Laboratory (EML)

Manager: Michael C. Campbell

Qualifications:

B.Sc. (Chemistry)	St. Francis Xavier
B.Eng. (Chemical Eng.)	Nova Scotia Tech College
D.I.C.	Imperial College (London)
M.Sc. (Met. Eng.)	University of London (Royal School of Mines)
P.Eng.	Ontario
16 years at CANMET	

Career:

1975-present	Manager, Extractive Metallurgy Laboratory, CANMET
1972-1975	Secretary, National Advisory Committee on Mining and Metallurgical Research

1967-1972	Vice-President & General Manager, Masterloy Products Ltd.
1963-1967	Manager, Pyrometallurgy, Geo-Met Reactors Ltd.
1960-1963	Project Engineer, DOSCO (Sydney Works)

EML conducts developmental studies and applied research in process metallurgy; this includes work in hydrometallurgy, pyrometallurgy, biotechnology and environmental protection. EML researchers and industry representatives work closely together to assure effective transfer of the technology to industry.

EML is a group of about 50 scientists, engineers and technologists with expertise in such areas as solution chemistry, separation technology, electrochemistry, thermochemistry, microbiology, and unit operations. Their research activities and achievements will be described in detail later in this presentation.

Chemical Laboratory

Manager: Henry F. Steger

Qualifications:

B.Sc. 1965, McMaster University

Ph.D. 1969, McMaster University

20 years at CANMET

Career:	1986-present	Manager, Chemical Laboratory, CANMET
	1985-1986	Manager, Measurements, NUTP, CANMET
	1976-1985	Research Scientist 2, CANMET
	1969-1976	Research Scientist 1, CANMET

The Chemical Laboratory provides analytical support for research projects, revenue operating cost-recovery projects within CANMET and also for industry, universities and other federal organizations. It has 45 professional, technical and administrative staff, and is equipped with extensive instrumentation to promote effectiveness and efficiency in its operation. Among the Chemical Laboratory's most important activities are the Canadian Certified Reference Materials Project (CCRMP) and the laboratory's collaboration with Canadian industry in the work of national and international standards organizations, such as the International Organizations for Standards (ISO) and the American Society for Testing of Materials (ASTM). Details of the personnel, programs and achievements of the laboratories of MSL are documented elsewhere in this presentation.

Office of Business Development

Manager: **Donald M. Doyle**

Qualifications:

B.Sc. Michigan Technological University

4 years at CANMET

Career:	1988-present	Manager, Office of Business Development, CANMET
	1986-1987	Section Head, MPL, CANMET

1983-1985	Sr. Metallurgical Consultant, Watts, Griffith & McOuat, Ltd.
1982-1983	General Sales Manager, Linatex Canada
1978-1982	General Manager, Research & Corporate Development, Indusmin Ltd.
1968-1977	Various Engineering capacities, Falconbridge Nickel Mines Ltd.
1965-1967	Lakefield Research of Canada Ltd.
1960-1964	Johns-Mannville Ltd.
1958-1959	Sherritt Gordon Mines Ltd.
1957-1958	Geco Mines Ltd. (Noranda)

The Office of Business Development (OBD) is located in Ottawa and has a representative in Vancouver, B.C. The office has a staff of four. Its purpose is to inform the mining mineral industry of MSL's expertise and capabilities, to assist the scientific staff in contacting and liaising with the industry and to help in the preparation of proposals, contracts and agreements. The OBD also keeps records of cost-recovery contracts, cost-shared projects and contributory agreements.

4. POLICY

4.1 Mineral and Metal Policy of Government (May 1987)

The Mineral and Metal Policy of the Government of Canada, adopted in May 1987, defines six objectives aimed at promoting the exploration,

development, production and utilization of Canada's mineral and metal wealth. Of particular interest to CANMET is the objective:

> "To promote improved technological performance and increased international competitiveness in all facets of the industry."

Several aspects of CANMET's work are linked to this objective. One is the effort to obtain greater industrial involvement in CANMET's R&D programs. Such involvement will directly strengthen industry's technological capability. Another is the significant and increasing emphasis in CANMET's programs on improving the health, safety and environmental impact of the mineral and metals industries.

4.2 Advisory Boards, Commissions and Parliamentary Committees

In recent years, Canadian policy for S&T has evolved at an accelerated pace. The Wright Report of 1984 and the Ministerial Task Force of 1985 recommended modification to the government's course of action in science and technology. Advisory bodies have been appointed, whose observations and recommendation have strongly influenced CANMET's plans and activities. The National Advisory Board on Science and Technology (NABST), which provides advice to, and is chaired by, the Prime Minister, and CANMET's own advisory board, the Minister's National Advisory Council to CANMET (MNACC), are two of CANMET's most important advisory bodies. The Minister's National Advisory Council to CANMET, as well as providing advice to CANMET, helps identify areas where CANMET's expertise can best help the development of the mineral and metals industries.

The Committee on Federal Science and Technology Expenditures was established by NABST in 1988 and is chaired by Mr. Pierre Lortie. The Committee's mandate is to examine the quality of science and technology in federal laboratories. Three departments, Communications, Health and Welfare and Energy, Mines and Resources were chosen for study. The study will involve:

- o obtaining the views of those involved in government R&D;
- o international peer reviews, to establish the quality of federal in-house science and technology;
- o bibliometric analyses, to examine the correlation between written output and quality of science and technology.

For CANMET, the Mineral Sciences Laboratories has been selected for the peer review portion of this study, and this presentation is in response to Mr. Lortie's Committee.

4.3 New Directions for CANMET

As a result of the evolving policy directions of the past 5 years, CANMET is in the midst of a major cultural change. CANMET's origin goes back to 1907, when as the Bureau of Mines, its mandate was to provide technical assistance to an emerging mining and mineral industry. The Bureau of Mines was the only source of experience and expertise available to many of the small mine operators, and its services were provided free of charge. This relationship endured until the 1960's; at that time a rapidly growing and mature mineral industry became independent of, and more distant from, the

Mines Branch. A sequence of crises in gold, uranium and oil over the 1950's, 1960's and 1970's directed CANMET's interests into national programs and led to a broadening of the gap between CANMET and the mining and mineral industry. CANMET's expertise was directed towards the scientific rather than the technological aspects of minerals and CANMET developed into an organization with an outlook that tended towards the academic. This climate endured at CANMET until the mid-1980's, when the impact of the recession of the early 1980's and the emergence of environmental and health and safety concerns as high-profile issues, drew together the needs of industry and the expertise of CANMET. CANMET's designation as a Technology Centre has formalized this "culture change".

In 1988, CANMET was officially designated as a Technology Centre by the federal government. This designation was the result of an extensive review of government policy for research and development in science and technology. The restructuring of CANMET that accompanied its designation as a Technology Centre allowed CANMET to respond directly to government priorities in R&D, which were identified as:

- o promoting economic, regional and social development;
- o increase industrial R&D;
- o help small and medium-sized technology-based companies;
- o improve technology transfer in Canada.

The Government of Canada directs its own S&T activities in order to help achieve the objectives of this national policy. It requires federally funded R&D to be performed in the private sector, provided this is compatible

with departmental missions. It also requires that federal R&D allocations be used to lever contributions by industry and provincial governments, to increase the overall level of R&D in Canada.

5. FACTORS AFFECTING CANMET'S PLANS AND OPERATIONS

CANMET's Business Plan must respond to a wide range of external factors that affect its operations. These factors include:

- o overall government policy;
- o the state of the economy;
- o Canada's import/export position and its impact on the demand for mineral and energy commodities;
- o the clientele;
- o environmental problems;
- o industrial R&D prospects and capabilities.

This section summarizes these factors.

5.1 Fiscal Restraint

Reducing federal expenditures is a key part of the government's program to reduce the federal deficit and thus strengthen the economy. Increased fiscal restraint has affected CANMET, as it has affected all other government agencies; CANMET has been required to scrutinize its programs carefully to ensure that its operations are conducted with maximum efficiency and effectiveness. This policy also emphasizes the importance CANMET already

assigns to recovering the cost of work done directly for a particular client, and in gaining leverage on its funds through joint programs with its clients.

5.2 Science and Technology and Regional Development

Applying S&T to support regional development is an integral part of economic development in a number of countries of the Organization for Economic Cooperation and Development. In Canada, the key regional development agencies, the Atlantic Canada Opportunities Agency and the Department of Western Economic Diversification, both include S&T in their support programs. The federal government has also entered into Mineral Development Agreements, and Economic and Regional Development Agreements, with a number of provinces. These agreements include funds for S&T projects that benefit the regions concerned.

CANMET plays a role in these initiatives by advising on the allocation of funds and on the development and management of projects. It also allocates its own resources to support these regional development initiatives. A particular aspect of CANMET's support to regional development is the expansion of its regional laboratories. In addition to existing laboratories in Alberta, northern Ontario and Nova Scotia, and a business development office in Vancouver, B.C., a new CANMET laboratory is being established in Quebec to focus on alternative energy resources.

5.3 Intellectual Property Policy

A good part of CANMET's output is intellectual property, which includes inventions, know-how and technological expertise. At present, government policies restrict the use CANMET may make of this property. For

example, ownership of intellectual property resulting from efforts involving federal employees or facilities must generally be retained by the Crown. This requirement can hinder CANMET's efforts to have such intellectual property exploited by the private sector for the benefit of Canadians. Similarly, R&D funded under government contracts usually contains clauses restricting ownership of the resulting intellectual property.

To address this issue, CANMET is chairing an interdepartmental committee to prepare a new technology transfer policy that will better respond to the challenges and opportunities in the current National Policy for Science and Technology. Development of a more appropriate policy will greatly facilitate CANMET's efforts to serve its clients, particularly those in industry.

5.4 Employment Equity

The Employment Equity Act requires private sector firms that have more than 100 employees and that wish to compete for government contracts in excess of $200,000 to comply with the Government of Canada's employment equity code. In addition, these firms must maintain very specific records of their employment practices and be open to audit by federal inspectors. In some cases maintaining the required records results in a significant increase in the administrative workload for the contractor, and has discouraged companies from participating in, and therefore benefiting from, federally funded R&D.

5.5 Free Trade Agreement

From CANMET's viewpoint, the most significant effect of the Free Trade Agreement will arise from the much larger, more secure market in which Canada's energy and mineral industries will operate in the future. For the energy sector, the agreement will result in greater investor confidence, leading to accelerated development of energy resources, particularly the oil sands and remote oil and gas fields. Building the required equipment and infrastructure, such as pipelines and offshore drilling rigs, will increase demand for technological expertise and development.

The mineral sector, as well as benefiting from increased demand for resources and a stronger investment climate, should see expanded opportunities for secondary processing as tariffs on manufactured and semi-manufactured goods are eventually eliminated. There will also be more opportunities to provide specialized services in mineral exploration and production. As for the energy sector, an important effect will be greatly increased demand for technology development.

5.6 Mineral Sector Outlook

The Canadian mineral industry, with few exceptions, is presently (1989) doing very well. Commodity prices are high and in general costs of production are low. The worldwide recession of 1981 produced a sharp decline in real prices of many mineral and metal commodities. The industry responded to this down-turn with sustained cost cutting, production rationalization and productivity improvements, including the introduction of new technologies.

As a result, the surviving companies are more productive and more competitive. The recent improvements in metal commodity prices dramatically increased the mineral industries profitability for 1987, 1988 and up to the present, in September 1989.

How long the favourable economic climate will last is an open question. High commodity prices, high interest rates, a strong Canadian dollar and supply-demand balances for the commodities all influence the competitive position of Canadian producers. Continued efforts by the producers to raise productivity, lower production costs, improve marketing and find new products and new applications for existing products are required to maintain their competitive position. Increased R&D in all these areas will be necessary to keep ahead.

5.7 Clients

MSL's principal clients are the companies and organizations associated with the recovery, processing, transportation, and end use of Canada's mineral and energy commodities. These include:

- o metals, minerals, coal, and oil sands mining industries;
- o mineral and coal processors;
- o mineral products companies;
- o foundries;
- o power utilities;
- o manufacturers of equipment for extracting and processing energy and mineral resources;
- o consulting companies to the mineral and energy industries.

The identity of specific industries are given later in the report. Other clients for MSL's technological services include other departments and agencies of the federal government, provincial governments, and occasionally industries that make specialty products for the mineral and energy industries, such as chemicals for use in mineral and coal processing. The chart in Figure 1.4 shows the diversity and scope of MSL's clients. An especially important group of clients is the standards writing organizations, such as the Canadian Standards Association and the Canadian General Standards Board. MSL also provides technical advice and guidance to industrial associations, universities, research groups in other countries, international agencies, granting agencies such as the Natural Sciences and Engineering Research Council, and to the general public.

5.8 Concern for the Environment

Protecting and enhancing the quality of the environment, both locally and globally, have become major concerns for the public and the private sector. These concerns are particularly important to CANMET because the mineral and energy sectors that are CANMET's principal clients depend on processes that, if not properly designed and managed, can contribute significantly to environmental problems. There will be increasing pressure on these client industries to reduce and where possible eliminate the emissions associated with environmental damage. There is also increasing support for the concept of sustainable development, under which all economic activity would be assessed to determine if it will adversely affect the quality of life and opportunities for future generations. Sustainable development particularly

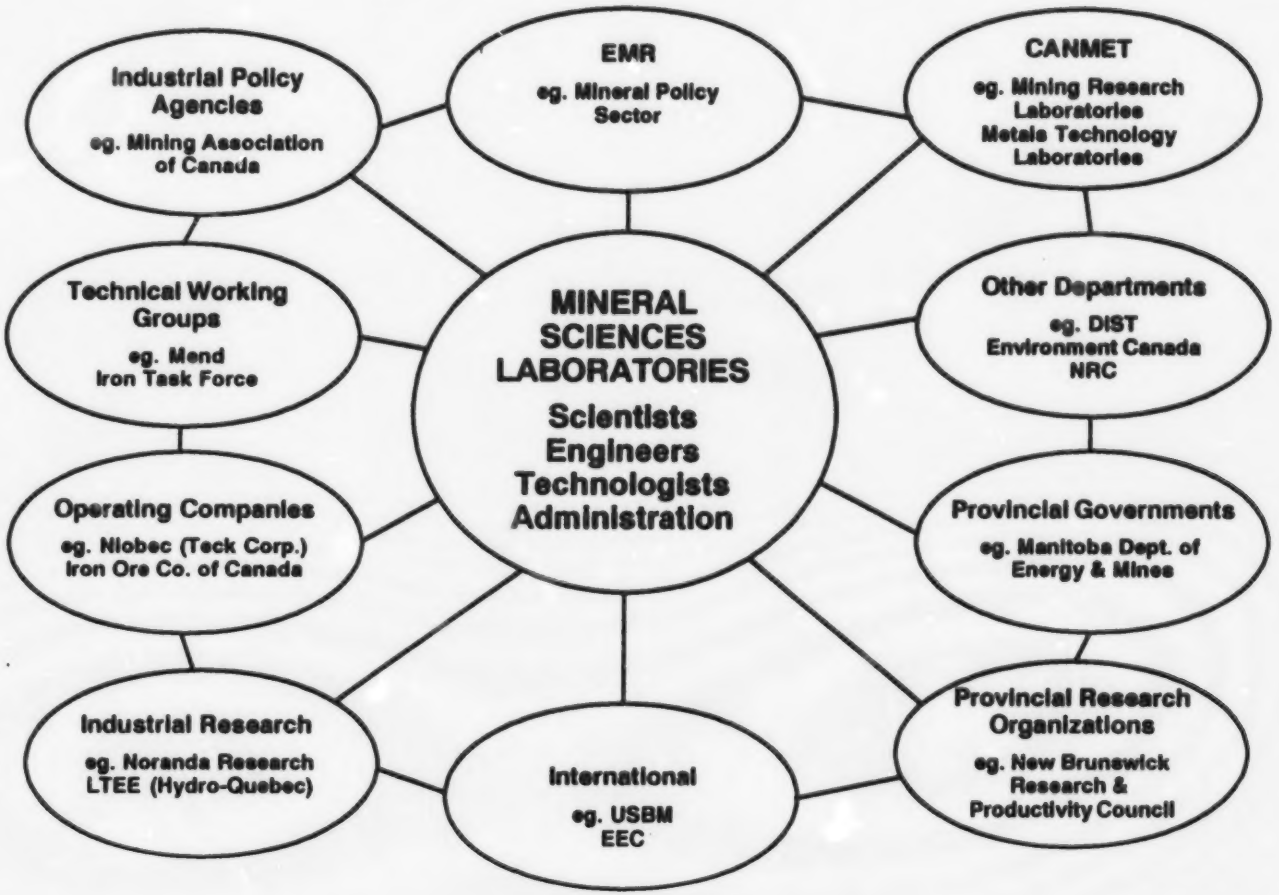


Figure 1.4

The clients of Mineral Sciences Laboratories

implies the development, in the long term at least, of alternatives to the extraction and use of non-renewable energy and mineral resources.

CANMET will be heavily involved in helping industry develop short term solutions to environmental problems, and longer term solutions that are compatible with sustainable development. It is probable that the demand for work on environmental issues could result in an increase in the proportion of CANMET's efforts devoted to Protection. This share is now approximately 30%.

5.9 Prospects and Capabilities

Specific issues that are likely to influence CANMET's activities include:

- **acid rain**, which is caused in part by coal-burning utilities and sulphide smelters;
- **acid mine tailings**, which threaten ground and surface water;
- **the greenhouse effect**, or global warming, which is caused by a number of factors, including carbon dioxide emitted during fossil fuel combustion, and methane emitted in the production and distribution of natural gas.
- **offshore oil and gas exploration and production, and offshore mining**, which can encounter technical failures with potentially major safety and environmental consequences;
- **the assessment and technological development of new energy sources and fuels**, depending on their relative environmental impact;
- **long term storage of nuclear wastes.**

These challenges also present CANMET with opportunities. CANMET scientists and managers will be able to refocus their R&D programs, and help develop the technological solutions that industry needs. The major efforts required to overcome environmental problems in both the minerals and the energy sectors will offer a particularly fruitful area for CANMET's R&D efforts.

6. STRATEGIC TECHNOLOGIES AND STRATEGIC DIRECTIONS FOR MSL

6.1 Strategic Technologies

It is well-recognized that strategic technologies will be important to future industrial development. Strategic technologies either enable other technologies to be used more effectively, or significantly improve existing processes. Examples include the application of biotechnology to processing of mineral and energy resources; the use of informatics, or electronic information technology, to run processing plants more effectively; and the application of advanced materials to improve equipment performance in difficult conditions. Many companies in the minerals sector will have to apply strategic technologies in order to develop new products and to improve the efficiency of their operations, to remain internationally competitive.

CANMET and MSL will play a key role in developing strategic technologies, and helping industry apply them to their operations. In many cases MSL has already developed the necessary expertise, and must apply it to new areas. One example is expert systems for guiding mineral processing operations; these systems could be applied widely in energy processing. Another

is the biological processing of mineral ores; this technology could also be useful in processing energy resources such as heavy oils and bitumen.

6.2 Strategic Directions

The review of factors that affect MSL and the associated issues and opportunities leads to a number of strategic directions that CANMET and MSL will follow in the planning period. These strategic directions form the basis for the detailed work plans of MSL's laboratories. This section describes these strategic directions; the order does not necessarily follow the order of importance. Of necessity there is considerable overlap among the programs that respond to these strategic directions.

6.3 Environment

CANMET's programs for the foreseeable future will reflect the growing concern for the environment. Areas of importance include proper treatment of effluent streams from mineral, coal and oil processing plants, control of emissions from smelters and power plants, and improved operating conditions in industrial facilities such as foundries. Maintaining and enhancing health and safety in all aspects of work in the mineral and energy sectors is an implicit aspect of concern for the environment.

6.4 Expert Systems

Expert systems have particular application in automating the operation of mineral and energy processing plants. CANMET has acquired considerable expertise in the use of expert systems in the design and operation of ore processing plants, and acts as a catalyst for the application of domain

expertise and knowledge engineering to process control. A strategic thrust for CANMET will be to apply this expertise in the field of energy processing, in addition to expanding its use in the minerals sector.

6.5 Mineral-Based Products

CANMET will dedicate its efforts to helping the mineral industry maintain its share of the market and develop new products. This will assist Canada's traditional resource-based industries to be more competitive. These industries are in danger of losing their traditional markets to newer materials. A critical element of the MSL strategy is the development of advanced mineral-based materials, especially advanced ceramics and advanced concrete. Advanced ceramic products will be developed in collaboration with Canadian manufacturers; the technology for new cementitious materials will be transferred to industry for exploitation through use in engineering practice.

6.6 Equipment Performance and Productivity

A critical aspect of improving productivity in Canada's processing operations is developing more advanced equipment and improved methods of operating. Of particular importance is the development of more sensitive and more durable process monitoring equipment. There is also scope for improving productivity through better ore beneficiation techniques and through application of new techniques such as microwave heating in extractive metallurgy. These aspects form an important strategic thrust for MSL's laboratories.

6.7 Process Efficiency and Recovery

Improved recovery from ores would provide major benefits to Canada's mineral and energy industries, and work in this area will form an important element of CANMET's strategic efforts. Particular topics of work will include new techniques for improved ore flotation, and the use of computerized process simulation techniques to help design improved processes, for example, in ore milling and concentrating plants.

6.8 Clean and Efficient Combustion of Fuels

Coal often contains higher proportions of contaminants such as sulphur and nitrogen than do other fuels. Both sulphur and nitrogen produce precursors of acid rain during combustion.

The development of technologies that will improve the environmental impact of coal burning will be a contribution not only to Canada's energy industry, but also to the world in general. Coal is so abundant and relatively cheap in many countries compared to other fuels that it is certain to be used widely for decades to come. The only way the world can mitigate the environmental effects of coal use is to develop technologies to reduce such emissions as carbon dioxide and oxides of sulphur and nitrogen.

6.9 Applications of Biotechnology

The value of strategic technologies such as biotechnology has been referred to on several occasions in this submission. CANMET's strategic thrusts will include the development of biotechnology techniques that can be applied to the processing of both energy and mineral resources. CANMET's

expertise in applying biotechnology to mineral ores will be further developed, and the existing knowledge base applied to such key energy areas as the processing of heavy oils and bitumens. Biotechnology also has an important role to play in waste treatment.

6.10 Strategic Administrative Thrusts

The strategic directions in technology development will be supported by a number of key thrusts in CANMET's administrative and support divisions. These thrusts will be aimed at increasing the efficiency of CANMET's management practices, and raising the level of service provided to the operating laboratories. An important aspect will be the development of innovative ways of overcoming obstacles that hinder CANMET's business activities. The administrative and support strategic thrusts are as follows:

- **Intellectual property** policies at present limit the extent to which CANMET can vest in the private sector intellectual property developed by CANMET's scientists, even if the costs of the work are paid by a private sector client. This often inhibits CANMET's efforts to develop and transfer technology to industry. CANMET will work with other departments and Treasury Board to develop a policy that would better meet the mission of the government's technology centres.

- CANMET's **information and marketing** activities will be improved to ensure that CANMET's programs and capabilities are widely publicised. The goal will be to establish a national and to an appropriate extent international marketing network.

- CANMET's **organizational structure** will be reviewed to ensure that the structure is the best for CANMET to meet the needs for future technology development in Canada's mineral and energy sectors. It is possible that an arrangement that allows greater administrative and financial flexibility could better meet CANMET's and industry's long term needs.

- **Management systems** are an essential tool in managing an organization like CANMET efficiently and effectively. The existing management and project information systems will be refined into a system that provides accurate management information clearly and promptly.

- **Research contracts** are an important part of CANMET's technology development and transfer tools. They are also important in gaining leverage on research funds through jointly funded research contracts with industry. The present system of letting contracts does not always allow CANMET to respond quickly to the needs of industry and to urgent research needs. A strategic goal for the planning period will be to improve the ways in which CANMET enters into research contracts.

- **Staff motivation** is an essential element in the success of any organization. It is especially critical in CANMET because of the major changes underway which include reorganizations in most of the divisions and changes in the ways of doing business. Strategic approaches to enhance employee morale will include devising more effective rewards for meritorious work,

maintaining clear communications at all levels, and emphasizing mechanisms for ensuring that all staff play a role in planning CANMET's future.

7. MSL'S WORK AREAS

7.1 The Areas

With the strategic directions for CANMET in mind, MSL's activities were tightened and redefined. The activities fall into 10 work areas, which are described below:

Process Mineralogy

From an assessment of the mineralogical nature of ores, the probable processing behaviour can be determined and processing options identified. The application of mineralogical techniques to intermediary mill products can define actual operating efficiencies and identify potential areas of improvement. At present, work is underway to allow a material balance program (BILMAT) to accept data directly from the image analysis program. The goal of this work is to combine image analysis techniques and quantitative mineralogy for the design of mill circuits, through the application of expert systems.

An important aspect in precious metal and refractory ores is to determine the mineralogical distribution of the precious metals (e.g., Au, Pt, Pd, Ag, etc.). The analytical problem of quantitative determination of low concentrations has been successfully solved by using ion probe microanalysis.

Ore Dressing

The effort in ore dressing is focussed on developing processing alternatives (e.g., column flotation), addressing specific processing problems (e.g., Cu-Zn separation, fine-particle handling) and improving process efficiencies (e.g., by process control). The ore dressing group provides expertise and services in the beneficiation of a wide variety of metallic and non-metallic ores and materials. Close collaboration is maintained with industry and a substantial amount of the work is directly funded by industry. The work in this area is more engineering oriented; this is reflected in the type of ongoing projects and in the profiles of the personnel.

Computer-Aided Mineral Processing

For a number of years, CANMET has worked in cooperation with universities and mineral producers to develop, apply and transfer easy-to-use computer based modelling, simulation and intelligent systems suitable for circuit evaluation, optimization and control. The initial product was the SPOC (Simulated Processing of Ores and Coal) family of programs which is available for purchase or licence through CANMET. Improvements to SPOC are made as warranted. The work has now evolved into the application of expert systems prototypes to mineral processing, particularly related to process control.

Pyrometallurgy

Pyrometallurgical operations are central to much of the Canadian mineral industry. CANMET is called upon to provide knowledgeable technical

advice. A modest level of research enables CANMET personnel to maintain their knowledge base and to advance science and technology in this field. Particular focus has been placed on developments related to improved process understanding and environmental control.

Hydrometallurgy

CANMET has widely recognized strength and depth of expertise in hydrometallurgy. The comprehensive study and understanding of the chemistry of metals in solution enables contributions to be made to the extraction and refining technologies of copper, zinc, gold, uranium, precious metals, rarer metals and by-products. Work in dissolution, precipitation, solution speciation, electrochemistry, ion exchange and solvent extraction serves a broad range of clientele.

Biotechnology

Biotechnology has been identified as one of several strategic technologies into which supplemental resources are being channelled by research funding agencies. CANMET has undertaken to examine, develop and promote applications in the mineral and fossil fuel industries. There is no tradition of biotechnology in these areas so that much of the work requires the demonstration of positive results for a variety of phenomena.

Environment

The protection of the environment in concert with mineral processing is a prime consideration in all research at CANMET. Specific research

objectives have been established to address problems related to the generation, treatment and disposal of solid liquid and gaseous wastes. The Mine Environment Neutral Drainage (MEND) program was launched to find more permanent, affordable, timely and environmentally sound solutions for the prevention and control of acid mine drainage (AMD). A full time coordinator for MEND was hired. Technology is being developed for the recovery and recycle of cyanide from gold mill effluents, and metallurgical sludges are being characterized to develop methods for their safe disposal.

Concrete Technology

CANMET has been serving the needs of the mineral based construction materials industry for several decades. Work in concrete technology assists the mining industry, aggregate, cement and concrete products companies, provincial agencies and utilities by: performing and sponsoring R&D in supplementary cementing materials, durability of cementitious systems, high performance concrete, development of innovative concretes and NDT methodology; participation in national and international standards development; sponsoring and organizing workshops and conferences to transfer technology.

Ceramics

CANMET has moved increasingly into the area of advanced ceramics with a decrease in emphasis on its former strength in traditional clay based materials. The objective is to develop technology for the fabrication and exploitation of advanced ceramics for both functional and structural applications and to demonstrate these applications through technology transfer. Some of the functional uses being worked on include sensors, NDT transducers,

high energy-density batteries, ion pumps and fuel cells. Structural applications include wear and corrosion resistant materials and high temperature high-strength materials. In addition, a substantial activity in refractories is maintained.

Analytical Standards and Methods

This work serves the Canadian analytical community through the certification of reference materials to ensure the reliability and quality of and the development of analytical methods to improve the capability of its chemical measurements. Support to the Canadian mineral industry is provided by cooperative participation in technical committees of standardization organizations to develop analytical methods intended to facilitate international trade.

7.2 Equipment and Facilities

MSL uses a wide range of equipment, from scanning electron microscopes, integrated with computer software for image analysis work, to standard non-specialized laboratory equipment such as flotation cells and pH meters. Details about the equipment will be included in the descriptions of the work areas in Book II.

7.3 Budget

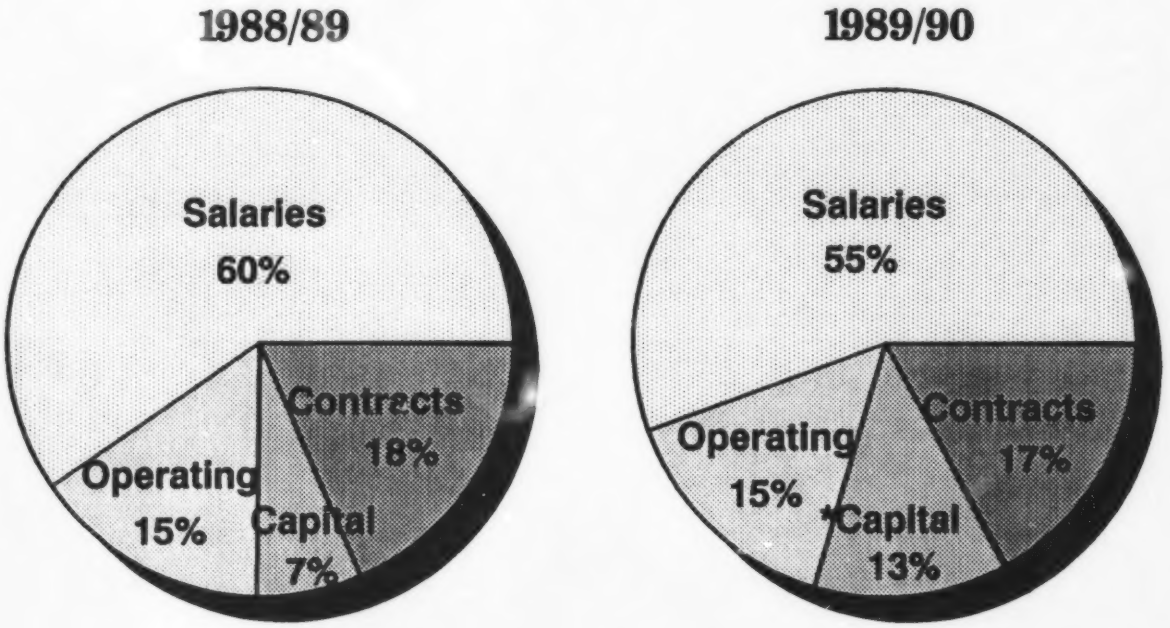
MSL's budget over the last five years is shown in terms of current-year dollars in Figure 1.5 and in constant dollars in Figure 1.7. Constant dollars are referenced to the consumer price index, using 1985/86 as the base year. These Figures, and the diagrams and graphs of Figures 1.6 and 1.8 show

$000					
	1985/86	*1986/87*	*1987/88*	*1988/89*	*1989/90*
Salaries	7947	7909	7224	7979	8141
Operating	1416	1541	1771	2048	2172
Capital	1135	916	987	897	*1848
Contracts	4681	4540	3466	2464	2475
Total	15179	14906	13448	13388	14636
Person-Years	196	186	190	192	182

Includes an additional $692,000
provided by the Capital Aquistion Replacement Program.

Figure 1.5

Mineral Sciences Laboratories budget allocations in current year dollars for the years 1985/86 to 1989/90



**Includes an additional $692,000 provided by the Capital Aquistion Replacement Program.*

Figure 1.6

Mineral Sciences Laboratories budget allocations in current year dollars for the years 1988/89, 1989/90

$000					
	1985/86	*1986/87*	*1987/88*	*1988/89*	*1989/90*
Salaries	7947	7634	6652	7949	6756
Operating	1416	1487	1631	1809	1802
Capital	1135	884	909	792	1534
Contracts	4681	4382	3192	2177	2054
Total	15179	14387	12384	11827	12146
Person-Years	196	186	190	192	182

Figure 1.7

Mineral Sciences Laboratories budget allocations shown in constant 1985/86 dollars for the years 1985/86 to 1989/90

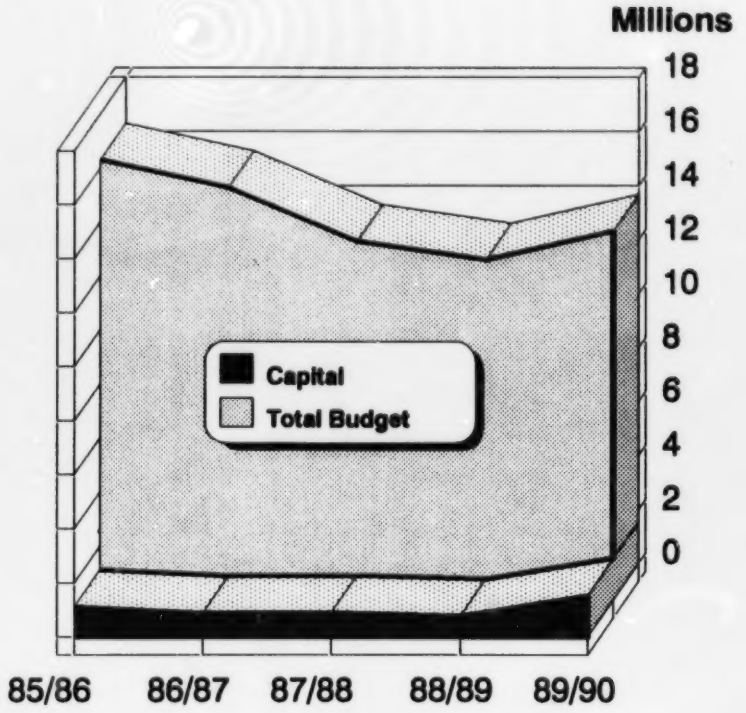


Figure 1.8

Trend of Mineral Sciences Laboratories capital and total budget allocations in constant 1985/86 dollars for the years 1985/86 to 1989/90

several important features; salaries is the largest single item in the MSL budget; in constant dollar terms the salary budget has decreased by $1.2 million over the period 1985/86 to 1989/90. This is reflected in the decrease in person-years (P.Y.) from 196 in 1985/86 to 182 in 1989/90. A downsizing exercise in 1988 lowered the Laboratories effectives by 15 P.Y.'s to 175 by eliminating redundant positions. There will be further cuts of 5 P.Y.'s in each of 1990 and 1991. A revitalization program is permitting MSL to hire young graduates, mostly PhD's, to act as future replacements for key retiring personnel. This program is allowing some continuity to be maintained within MSL and CANMET and is permitting MSL to increase the 175 P.Y. target for the fiscal year to 182 P.Y. Because of reductions in the capital budget allocation, MSL has traded off some of its redundant P.Y.'s to increase its capital and operating funds for the 1989/90 fiscal year, as permitted by Treasury Board guidelines; this has allowed MSL to maintain its capital and operating funds at a more acceptable level. Included in the 1989/90 capital figure is the sum of $692,000, obtained through the Capital Acquisition Replacement Program (CARP). This source of funds has increased the capital budget to $1.8 million for the 1989/90 year, however, it is not known at this time if the CARP funds will be available in the next and subsequent fiscal years. A further feature of the capital and operating budget is that MSL now is required to contribute to the funding of some services such as tenant services.

Revenue is also generated by MSL through its cost-recovery projects; under current guidelines, 20% of dollars earned through cost-recovery projects are returned to CANMET as an incentive.

MINERAL SCIENCES LABORATORIES

PROFESSIONAL, TECHNICAL AND ADMINISTRATIVE STAFF

* Indicates that a complete curriculum vitae is available in Book 3.

DIRECTOR's OFFICE	DEGREES	OCCUPATIONAL CATEGORY
Sirois, L.L.	B.A., B.Eng., (McGill); M.Eng. (McGill); P.Eng.	Director MSL
Berlinguette, L.		Secretary
Craigen, W.J.S.	B.Sc. (Queen's)	Phys. Scientist
Joe, E.G.	B.Sc. (Queen's)	Phys. Scientist
ADMINISTRATION		
Rochon, J.P.		Administrative Officer
Bisson, S.		Word Processing Operator
Carbonetti, S.		Word Processing Operator
Cook, D.		General Services Clerk
Desrochers, L.R.		Office Manager
Emmerson, M.		Procurement Clerk
Groulx, P.		Procurement Clerk
Hindle, K.A.		Administrative Clerk
Joly, A.		Travel Clerk
Lord, S.		Report Reproduction Clerk
MacLeod, J.D.		Scientific Illustrator
Moir, B.		Procurement Clerk
Palmer, M.		Supervisor Reproduction Clerk
Villeneuve, J.		Word Processing Operator

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OFFICE OF BUSINESS DEVELOPMENT		
Doyle, D.M.	B.Sc. Min. Eng. (Michigan Technical Univ.)	Phys. Scientist
Lavallée L.R.	Secretary	
Loucks, N.D.	Administrative Clerk	
Tremblay, G.	B.Eng. (Civil) (Carleton)	Phys. Scientist
CHEMICAL LABORATORY		
* Steger, H.F.	B.Sc., Ph.D. (McMaster)	Manager
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Barkley, D.J.	B.Sc. (Carleton)	Chemist
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Carson, D.W.	Diploma, Electronics Technology (Algonquin College)	Technologist
Charbonneau, R.		Technologist
Chenier, M.	D.E.C., Chimie Analitique (CEGEP de l'Outaouais)	Technologist
Churchill, T.R.	B.Sc. (Western Ontario)	Chemist
Cloutier, J.C.	D.E.C., Chimie Analitique (CEGEP de l'Outaouais)	Technologist
Cyfracki, E.	Chemical Technology (Poland)	Technologist
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Duguay, S.	Commercial Art Diploma (Algonquin)	Technical Illustrator

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Grenon, R.L.		Storekeeper
Guillas, R.J.	Diploma, Chemical Technology (Red River Community College)	Technologist
Hole, J.C.	B.A. (Toronto)	Chemist
Horton, R.E.	B.Sc. (Carleton)	Chemist
Karwowska, R.	M.Sc., Ph.D. (Warsaw)	Chemist
Lalande, L.L.		Lab. Support
Leaver, M.E.	B.Sc. (Queen's)	Chemist
MacEachern, E.H.	B.Sc. (Mount Allison)	Chemist
McIntosh, D.G.		Tech. Support
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Laflamme, J.H.		Technologist

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* Ahmed, S.M.	B.Sc., M.Sc. Ph.D. (Saskatchewan)	Res. Scientist
Béchard, G.	B.Sc., M.Sc. (Univ. du Québec)	Phys. Scientist
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Bowman, W.S.	B.Sc. (Carleton)	Phys. Scientist
Brannen, J.M.		Technologist
Carter, L.E.		Technologist
Chalykoff, C.	B.Sc. (Carleton)	Technologist
Currie, M.L.		Secretary
Deschênes, G.	B.Sc., M.Sc. (Laval)	Phys. Scientist
Dinardo, O.	B.Sc. (Carleton)	Phys. Scientist
Dubreuil, A.	B.Sc. (Monteal U.) M.Sc.A. (Met. Eng.) (Polytechnique) Ph.D. (Met. Eng.)	Res. Scientist
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* Filion, M.P.	B.A.Sc. (Waterloo) M.Eng. (McMaster)	Phys. Scientist
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* MacKinnon, D.J.	B.Sc., M.A.; Ph.D. (Ottawa)	Res. Scientist
* McCready, R.G.L.	B.Sc., M.Sc. (Alberta); Ph.D. (Calgary)	Res. Scientist
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Mikhail, S.A.	B.Sc., Ph.D. (Cairo); Dr.Eng. (Norway)	Res. Scientist
* Molnar, R.	B.Eng. (McGill); Ph.D. (Univ. of London); D.I.C.	Phys. Scientist
Morrison, R.M.	B.Sc., Ph.D. (UBC)	Res. Scientist
Paquette, L.A.		Secretary
Prud'homme, P.J.A.	Diplome, Chimie Industrielle (Institut de Technologie, Laval)	Technologist
Rajan, S.	Diploma, Medical Technology (Madras); Hydrometallurgy (BCIT)	Technologist
Ritcey, G.M.	B.Sc. (Dalhousie)	Res. Scientist
Riveros, P.	Ph.D. (Queen's Univ.) M.Sc. (Univ. of Bradford, U.K.)	Res. Scientist
Salley, J.	B.Sc. (Ottawa)	Phys. Scientist

NAME	DEGREES	OCCUPATIONAL CATEGORY
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Shimano, D.Y.	B.Sc. (Concordia)	Phys. Scientist
Sideco, C.	B.Sc. Min.Eng. (Univ. of Philippines) M.Sc. Met.Eng. (Univ. of Washington)	Phys. Scientist
Skaff, M.	B.Sc. (Carleton)	Technologist
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